CLAIMS

[1] A Group III nitride semiconductor crystal manufacturing method, comprising:

a step of growing at least one Group III nitride semiconductor crystal on a starting substrate; and

a step of separating said Group III nitride semiconductor crystal from said starting substrate; characterized in that

said Group III nitride semiconductor crystal is 10 μm or more but 600 μm or less in thickness, and is 0.2 mm or more but 50 mm or less in width.

[2] The Group III nitride semiconductor crystal manufacturing method recited in claim 1, characterized in that the principal face of said Group III nitride semiconductor crystal is smaller in area than the principal face of said starting substrate.

[3] The Group III nitride semiconductor crystal manufacturing method recited in claim 1, characterized in that said step of growing at least one said Group III nitride semiconductor crystal includes:

a step of forming on said starting substrate a mask layer having at least one window; and

a step of growing said Group III nitride semiconductor crystal at least on an open surface of said starting substrate below said window in said mask layer.

[4] The Group III nitride semiconductor crystal manufacturing method recited in claim 3, characterized in that said window is formed from a group composed of at least two micro-apertures.

[5] The Group III nitride semiconductor crystal manufacturing method recited in claim 1, characterized in that said step of growing at least one said Group III nitride semiconductor crystal includes:

a step of disposing at least one seed crystal on said starting substrate; and

a step of growing said Group III nitride semiconductor crystal with said seed crystal as its nucleus.

[6] The Group III nitride semiconductor crystal manufacturing method recited in any one of claims 1 to 5, characterized in that whichever of an etching, lasing, or cleaving method is used in said step of separating from said starting substrate said Group III nitride semiconductor crystal.

[7] The Group III nitride semiconductor crystal manufacturing method recited in any one of claims 1 to 6, characterized in that the conformation of said Group III nitride semiconductor crystal is hexagonal-platelike, rectangular-platelike, or triangular-platelike.

[8] The Group III nitride semiconductor crystal manufacturing method recited in any one of claims 1 to 7, characterized in that said Group III nitride semiconductor crystal is grown at a rate of at least 10/hr but not more than 300 μm/hr.

[9] The Group III nitride semiconductor crystal manufacturing method recited in any one of claims 1 to 7, characterized in that said Group III nitride semiconductor crystal has an impurity concentration that is not more than 5×10^{19} cm^{-3}.

[10] The Group III nitride semiconductor crystal manufacturing method recited in any one of claims 1 to 7, characterized in that an off angle between the principal face of said Group III nitride semiconductor crystal and whichever of its (0001) face,

$(1\bar{1}00)$ face, $(11\bar{2}0)$ face, $(1\bar{1}01)$ face, $(1\bar{1}02)$ face, $(11\bar{2}1)$ face, or $(11\bar{2}2)$ face is 0° or more but not more than 4°.

[11] A Group III nitride semiconductor crystal manufactured using a Group III nitride semiconductor crystal manufacturing method recited in any one of claims 1 to 10.

[12] A method of manufacturing a Group III nitride semiconductor device, comprising:

a step of growing at least one Group III nitride semiconductor crystal substrate on a starting substrate;

a step of growing at least one Group III nitride semiconductor crystal layer on said Group III nitride semiconductor crystal substrate; and

a step of separating from said starting substrate a Group III nitride semiconductor crystal that is constituted by said Group III nitride semiconductor crystal substrate and said Group III nitride semiconductor crystal layer;

characterized in that

said Group III nitride semiconductor crystal is 10 μm or more but 600 μm or less in thickness, and is 0.2 mm or more but 50 mm or less in width.

[13] The method of manufacturing a Group III nitride semiconductor device recited in claim 12, characterized in that the principal face of said Group III nitride semiconductor crystal substrate is made smaller in area than the principal face of said starting substrate.

[14] The method of manufacturing a Group III nitride semiconductor device recited in claim 12, characterized in that said step of growing at least one said Group III nitride semiconductor crystal substrate includes:

a step of forming on said starting substrate a mask layer having at least one window; and

a step of growing said Group III nitride semiconductor crystal substrate at least on an open surface of said starting substrate below said window in said mask layer.

[15] The method of manufacturing a Group III nitride semiconductor device recited in claim 14, characterized in that said window is formed from a group composed of at least two micro-apertures.

[16] The method of manufacturing a Group III nitride semiconductor device recited in claim 12, characterized in that said step of growing at least one said Group III nitride semiconductor crystal substrate includes:

a step of disposing at least one seed crystal on said starting substrate; and

a step of growing said Group III nitride semiconductor crystal substrate with said seed crystal as its nucleus.

[17] The method of manufacturing a Group III nitride semiconductor device recited in any one of claims 12 to 16, characterized in that whichever of an etching, lasing, or cleaving method is used in said step of separating from said starting substrate said Group III nitride semiconductor crystal constituted by said Group III nitride semiconductor crystal substrate and said Group III nitride semiconductor crystal layer.

[18] The method of manufacturing a Group III nitride semiconductor device recited in any one of claims 12 to 17, characterized in that the conformation of said Group III nitride semiconductor crystal substrate and said Group III nitride

semiconductor crystal layer is hexagonal-platelike, rectangular-platelike, or triangular-platelike.

[19] The method of manufacturing a Group III nitride semiconductor device recited in any one of claims 12 to 18, characterized in that said Group III nitride semiconductor crystal substrate is grown at a rate of at least 10 m/hr but not more than 300 μm/hr.

[20] The method of manufacturing a Group III nitride semiconductor device recited in any one of claims 12 to 18, characterized in that said Group III nitride crystal substrate has an impurity concentration that is not more than 5×10^{19} cm^{-3}.

[21] The method of manufacturing a Group III nitride semiconductor device recited in any one of claims 12 to 18, characterized in that an off angle between the principal face of said Group III nitride crystal substrate and whichever of its (0001) face, $(1\bar{1}00)$ face, $(11\bar{2}0)$ face, $(1\bar{1}01)$ face, $(1\bar{1}02)$ face, $(11\bar{2}1)$ face, or $(11\bar{2}2)$ face is 0° or more but not more than 4°.

[22] A Group III nitride semiconductor device manufactured using a method of manufacturing a Group III nitride semiconductor device recited in any one of claims 12 to 21.

[23] The Group III nitride semiconductor device recited in claim 22, characterized in that a roughned surface is formed in on the back side of said Group III nitride semiconductor crystal substrate.

[24] The Group III nitride semiconductor device recited in claim 23, characterized in that the surface roughness R_{P-V} of said roughened surface formed on the back side of said Group III nitride semiconductor crystal substrate is at least 0.01 μm but not more than 50 μm.

[25] A light-emitting appliance comprising a Group III nitride semiconductor device recited in any one of claims 22 to 24, characterized in that:

said Group III nitride semiconductor device is furnished with said Group III nitride semiconductor crystal substrate, an n-type Group III nitride semiconductor layer on a first principal face side of said Group III nitride semiconductor crystal substrate, a p-type Group III nitride semiconductor crystal layer located farther from said Group III nitride semiconductor substrate than is said n-type Group III nitride semiconductor crystal layer, and a light-emitting layer that is located between said n-type Group III nitride semiconductor crystal layer and said p-type Group III nitride semiconductor crystal layer;

said Group III nitride semiconductor crystal substrate has a resistivity of 0.5 Ω·cm or less; and

said p-type Group III nitride semiconductor crystal layer side is mounted down, and light is irradiated from a second principal face, being the principal face on the side of said Group III nitride semiconductor crystal substrate opposite said first principal face.

[26] A light-emitting appliance comprising a Group III nitride semiconductor device recited in any one of claims 22 to 24, characterized in that:

said Group III nitride semiconductor device is furnished with a GaN substrate being said Group III nitride semiconductor crystal substrate, an n-type $Al_xGa_{1-x}N$ layer ($0 \leq x \leq 1$), being an n-type Group III nitride semiconductor layer, on a first principal face side of said GaN substrate, a p-type $Al_xGa_{1-x}N$ layer ($0 \leq x \leq 1$), being a p-type Group III nitride semiconductor crystal layer, located farther from said

GaN substrate than is said n-type $Al_xGa_{1-x}N$ layer, and a light-emitting layer located between said n-type $Al_xGa_{1-x}N$ layer and said p-type $Al_xGa_{1-x}N$ layer;

the dislocation density of said GaN substrate is not more than $10^8/cm^2$; and

said p-type $Al_xGa_{1-x}N$ layer side is mounted down, and light is irradiated from a second principal face, being the principal face on the side of said GaN substrate opposite said first principal face.

[27] A light-emitting appliance comprising a Group III nitride semiconductor device recited in any one of claims 22 to 24, characterized in that:

said Group III nitride semiconductor device is furnished with a AlN substrate being said Group III nitride semiconductor crystal substrate, an n-type $Al_xGa_{1-x}N$ layer ($0 \leq x \leq 1$), being an n-type Group III nitride semiconductor layer, on a first principal face side of said AlN substrate, a p-type $Al_xGa_{1-x}N$ layer ($0 \leq x \leq 1$) being a p-type Group III nitride semiconductor crystal layer located farther from said AlN substrate than is said n-type $Al_xGa_{1-x}N$ layer, and a light-emitting layer located between said n-type $Al_xGa_{1-x}N$ layer and said p-type $Al_xGa_{1-x}N$ layer;

the thermal conductivity of said GaN substrate 100 W/(m·K) or more; and

said p-type $Al_xGa_{1-x}N$ layer side is mounted down, and light is irradiated from a second principal face, being the principal face on the side of said AlN substrate opposite said first principal face.